Elmer Press

Original Article

J Endocrinol Metab • 2012;2(6):228-231

Relation of Ankle Brachial Index to Left Ventricular Ejection Fraction in Diabetic Patients

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Abstract

Background: Peripheral arterial disease is associated with an excessive risk for cardiovascular events and mortality. It is usually measured with ankle brachial index (ABI), which is shown to be influenced by left ventricular ejection fraction (LVEF) independent of coronary disease. Diabetics significantly have higher risk for cardiovascular disease. The aim of current study is to evaluate relation of ABI to LVEF in diabetic patients.

Methods: Seventy-five diabetics (36% male with mean age of 59.98 ± 10.27 years) referred for ABI determination that had the LVEF determined using trans-thoracic echocardiography was studied. Participants were compared in normal (ABI > 1, n = 54) and low ABI (ABI < 1, n = 21) groups.

Results: The mean LVEF was 48.61 ± 10.74, and mean ABI for both legs was 1.06 ± 0.11. There was no difference in demographic findings between ABI low and normal. There was no difference in ABI values according to diabetes duration. In cases with low ABI, LVEF below 50% was higher than normal ABI (85.7% vs. 18.5%, p < 0.001). Peripheral neuropathy existed in 37% of normal ABI and 66.7% of low ABI (P = 0.037). Low ABI was independently associated with LVEF with Odds ratio of 0.04 (confidence interval between 0.01 to 0.17, p < 0.001).

Conclusions: ABI would be influenced by LVEF in diabetics, but not considering the diabetes period and to evaluate and monitor cardiovascular risk in patients, these should be considered together.

Manuscript accepted for publication December 15, 2012

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doi: http://dx.doi.org/10.4021/jem143e

Keywords: Diabetes; Left ventricular ejection fraction; Ankle brachial index

Introduction

The ankle brachial index (ABI) is a simple non-invasive test, reflecting the ratio of the systolic blood pressure (SBP) in the ankle divided by SBP in the brachial artery. Low ABI measurements (< 0.90) have been studied as a marker of atherosclerotic peripheral arterial disease (PAD) for over 40 years [1]. PAD is commonly assessed by the measurement of ABI [2]. Numerous studies have found low ABI values to be an independent predictor of cardiovascular events, including myocardial infarction, stroke, and mortality [3]. Normal values generally range from 1.2 to 1.4 [4].

Although CAD is often accompanied by LV systolic dysfunction [5], data relating ABI values to LV structural and functional abnormalities are sparse. Recently, low ABI values have been found to be associated with LV hypertrophy [6, 7] a well-known risk factor for LV dysfunction and heart failure [8].

The ratio is > 1.0 because the shape of the arterial waveform changes from the central aorta to the periphery, with the systolic blood pressure increasing at peripheral sites owing to arterial waveform reflection and summation [9]. Because left ventricular (LV) systolic function has been shown to influence arterial wave reflective properties [10], it is presumed that the ABI would reflect LV systolic function, as well as atherosclerosis. Recent study showed that the ABI might be influenced by LV systolic function, independent of coronary disease [11]. However this is the first study reporting this probability.

Diabetes increases the incidence of cardiovascular events, leading to significant morbidity and mortality [12]. In comparison to people without diabetes, there is more possibility of complications in coronary circulation, tendency to atherosclerosis and higher incidence of extended coronary artery disease in diabetics [13]. Exact measurement of ventricular function in diabetic patients has an important role in

Table 1. Demographic and Clinical Parameters in All Patients and Different ABI

	Normal ABI (n = 54)	Low ABI (n = 21)	All (n = 75)	P value
Age (yr)	58.59 ± 10.46	63.57 ± 9.03	59.98 ± 10.27	0.06
Male	22 (40.7%)	5 (23.8%)	27 (36%)	0.19
Diabetes period < 10 yr	34 (63%)	11 (52.4%)	45 (60%)	0.44
Hypertension	42 (77.8%)	18 (85.7%)	60 (80%)	0.53
Hyperlipidemia	35 (64.8%)	12 (57.1%)	47 (62.7%)	0.60
Current smoking	15 (27.8%)	5 (23.8%)	20 (26.7%)	0.91
IHD	21 (38.9%)	8 (38.1%)	29 (38.7%)	0.94
Ejection fraction	50.94 ± 10.47	42.61 ± 9.16	48.61 ± 10.74	0.002
Left ventricle ejection fraction < 50%	11 (18.5%)	18 (85.7%)	28 (37.3%)	< 0.001
Right ABI	1.11 ± 0.08	0.92 ± 0.05	1.06 ± 0.11	< 0.001
Left ABI	1.10 ± 0.08	0.90 ± 0.05	1.06 ± 0.11	< 0.001

future treatment plans. Current study evaluates relation of ankle brachial index to left ventricular ejection fraction in diabetic patients.

Materials and Methods

Seventy-five diabetic patients were enrolled in this study. Inclusion criteria were patients with type I diabetes more than 10 years or diabetes type II. Exclusion criteria were acute cardiovascular, cerebral, infectious or other active disease in the time of study, history of deep vein thrombosis, severe and non tolerable lower limb pain, PAD calcification which was considered in ABI > 1.4. Informed consent was obtained from all patients, and the study was carried out following the principles of the Helsinki Declaration (Edinburgh Amendment, 2000).

All patients undergone ABI determination and had transthoracic echocardiographic studies within 14 days without clinical events or a known change in clinical status. After the participants had rested in the supine position for at least 10 minutes, the systolic ankle blood pressures were measured at the right and left brachial, dorsalis pedis, and posterior tibial arteries by trained technicians using a Doppler ultrasound instrument (Huntleigh). The right and left ABI values were calculated by dividing the right and the left ankle pressure by the greater of the 2 brachial systolic blood pressures. The greater of the dorsalis pedis and posterior tibial artery pressure was used. Participants were divided into two groups: low ABI if either leg had an ABI of ≤ 1 and normal ABI if both legs had an ABI ≥ 1 but < 1.40.

Transthoracic echocardiography was performed in all participants and interpreted by experienced echocardiographer blinded to the ABI results. The LV dimensions were measured from M mode images according to the American Society of Echocardiography standards. Two-dimensional images were used when the scanning axis was not perpendicular to the axis of the heart. Left ventricular EF was measured either by echocardiography using the Simpson or eye ball method. A normal LVEF was defined as ≥ 50%.

Clinical data were obtained from the vascular database and patient medical records. The clinical variables included age, hyperlipidemia, hypertension, current cigarette smoking, and known coronary artery disease (CAD), defined as previous documented myocardial infarction, abnormal stress test results, or ≥ 50% stenosis by coronary angiography. Hyperlipidemia and hypertension were defined as either a documented diagnosis obtained from chart review or current treatment with medication.

Statistical analysis

Continuous data with normal distribution are given as mean ± standard deviation, otherwise as median; student t test for testing the significance of mean for independent continuous scale data and Chi-square or Fisher exact test for testing the significance of percentages were used. Association between variables and low ABI was assessed by logistic regression. A P value of 0.05 or less was considered significant. Statistical analyses were performed using the Statistical Package for Social Sciences, version 13.0 (SPSS, Chicago, Illinois).

Results

The patient characteristics are listed in Table 1. There were significant differences between groups in ejection fraction and right and left ABI values. Although not significant, low ABI was higher in older patients, longer diabetes duration and female patients. Mean LVEF was higher in normal ABI (P = 0.002). LVEF < 50% was significantly higher in Low ABI (85.7%) than normal ABI (18.5%, P < 0.001).

Lower extremity symptoms

One case (1.3%) had claudication, 34 cases (45.3%) had peripheral neuropathy, 4 (5.3%) had nail changes and 2 (2.7%) diabetic foot. Peripheral neuropathy existed in 20 cases (37%) of normal ABI and 14 cases (66.7%) of low ABI (P = 0.037).

Considering significant variables between groups, low ABI was independently associated with LVEF with Odds ratio of 0.04 (confidence interval between 0.01 to 0.17, P < 0.001) but not with peripheral neuropathy.

Discussion

In this study we found that in diabetic patients, ABI < 1 is accompanied by lower LVEF. Singh et al [14] observed that among diabetic patients, low ABI was independently related to lower age, female sex, black race, diabetes period, lower BMI, hypertension, current smoking and higher CRP. In our study the only significant association was between low ABI and LVEF.

A higher prevalence of PAD among women with diabetes has been observed. However slightly lower slightly lower normal ABI values are reported in women with diabetes [15]. Older age and smoking are associated with the presence or progression of PAD in patients with diabetes [14, 16, 17]. In our study, although not significant, low ABI was higher in older patients, longer diabetes duration and female patients.

Recent study showed that the ABI might be influenced by LV systolic function independent of coronary disease [11]. Ward et al [18] in the study of 204 patients with symptomatic PAD found that LVEF less than 55% among patients with low ABI is more common than normal ABI. Also in the study by Santo Signorelli et al [19] LVEF < 50% had higher prevalence in patients with ABI ≤ 0.9. Unlike these findings, Thatipelli et al [20] studied 395 patients referred for dobutamin stress echocardiography and ABI determination, and observed that there was no relation between ABI and left ventricle wall motion index score at rest or after stress. Results of current study in diabetic patients are in consistent with these studies but not Thatipelli et al [20]. These different findings between these studies could be probably due to differences in population under study in each research and method of left ventricle function and ejection fraction measurement.

Similar to our study, Rizvi and coworkers found that mean LVEF significantly increased from low ABI to normal and high ABI. ABI was independently related to LVEF [11]. Results of current study showed that ankle brachial index would be influenced by left ventricular ejection fraction in diabetics, and the diabetes period as well as the evaluation and monitoring of cardiovascular risk in patients should be considered together.

Acknowledgement

This research was financially supported by Vice Chancellor for Research, Tabriz University of Medical Sciences, Iran. The authors are indebted to Cardiovascular Research Center, Tabriz University of Medical Sciences, Tabriz, Iran for its support. The authors have no conflicts of interest.

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